FROM FOREST TO FIRESIDE

By JAMES R. ROBINSON

DID YOU know that in 1936 the average U. S. citizen "consumed" 226 pounds of paper? That during this same time he used less than half that much meat? Paper is everywhere. You are besieged at every street corner by insistent newsboys—"Get your paper here, mister!" The books that line your shelves, the magazine you pick up in the evening, even the money in your billfold—all these are paper. You are staring at it now as you read. Did you ever wonder about the origin of this mighty deluge?

Paper is essentially a sheet of matted cellulose fibers. It may be strong and tough, it may be light and delicate; it may be fine enough for a magnificent first edition, it may be fit only for the wrapping of parcels. Despite all its forms and uses, its basic manufacture is the same. We shall limit ourselves here to a discussion of "book paper" as distinguished from newsprint and other types.

In a broad sense, papermaking naturally falls into two divisions: the preparation of pulp, the major constituent of paper, and the operations relative to the actual production of the sheet. Without pulp we could have no paper. Therefore we shall consider first how it is secured.

Wood is, at the present time, the raw material most used in the paper pulp industry. Obviously it must undergo some remarkable changes before it even bears any resemblance to paper. There are several methods by which wood is "digested", with the aim of finally obtaining practically pure cellulose. We shall deal with only one of these, the soda process, especially adapted for the use of poplar, cottonwood, beech, birch, maple, pine, and similar woods. The soda process for the manufacture of chemical wood pulp depends on the chemical fact that alkali at high temperatures will dissolve all the foreign substances, leaving the cellulose in a form suitable for paper manufacture.

As a preliminary step, the wood is "barked", sawed, and split into pieces of a size convenient for handling. The "sticks" are fed one by one into a chipper, a very sturdy machine containing a heavy revolving wheel on which are bolted steel knives. The wood is sliced off in more or less uniform chips which are conveyed to shaker screens where the knots and oversize pieces and the sawdust are removed. They are then blown or otherwise transferred into chip bins, ready to be placed in the digesters.

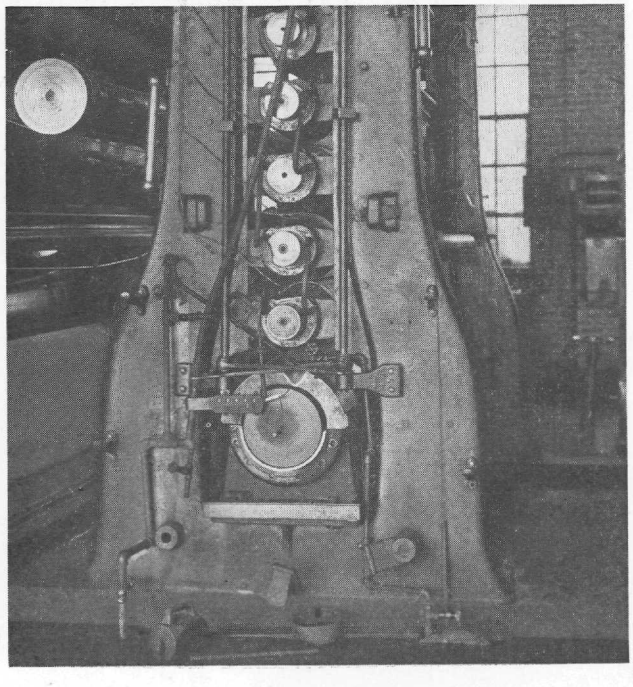
These are large steel cylinders, either stationary or rotary, conical at both ends. A common size is about 15 feet in diameter and 40 feet in height. After they are filled with chips, the heads are bolted on and caustic soda solution and steam under pressure are admitted. The cook is maintained for a period of from three to six hours, varying with several factors. After completion, the valve at the bottom of the digester is opened and the contents are blown into a receiving tank. A series of thorough washings follow in which the caustic liquor is recovered and all foreign matter is removed. The pulp at this stage has a gray or brown color.

Wood pulp, regardless of the process by which it is made, must be bleached if it is to be used in any of the finer varieties of white or light colored paper. Bleaching is primarily an oxidizing reaction. Chlorine, or some compound of chlorine, is most commonly used because it reacts with water to release oxygen which exerts a strong decolorizing action on the fiber. The pulp is circulated through a series of continuous tanks, with bleaching agent added, until the desired degree of whiteness is attained. The pulp is now ready to be pumped to the paper mill.

The manufacture of paper starts in the beater room. Pulp is not paper; it is merely one of the raw materials of paper, of which there are a number of others of lesser importance, e.g., clay, size, color, etc. There are many large mills which do not prepare pulp, instead they buy

Side view of one of the roller stands showing waterproof bearings.

Courtesy—Westinghouse



this material from other plants which stop with the manufacture of pulp and do not proceed to make it into paper. As a matter of fact, pulp itself constitutes one of the chief exports of the Scandinavian countries.

The beaters are large oval, tank-like machines constructed of thick cypress planks or, more often, of iron. A usual size is about 25 feet long by 11 feet wide; several beaters are needed to furnish sufficient stock for one machine. [As is true in other industries, methods and machines are frequently being changed in the paper industry. There are beaters differing radically from the above specifications in use today. It is not our purpose to discuss such variations.]

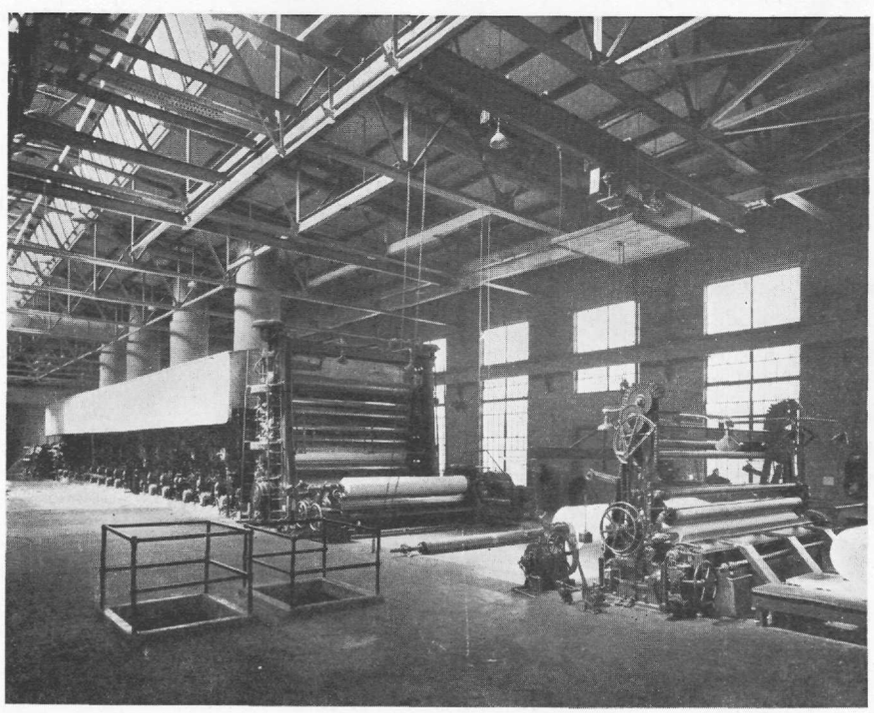
When the pulp comes from the pulp mill, the fibers are in bundles and in more or less compact lumps. The function of the beater is to separate these bundles and to brush or stroke the fibers into greater flexibility. To accomplish this, the beater is equipped with a cylindrical beater roll, in which are set a number of steel bars or knives. At the bottom of the tank, directly under this roll, is a bed-plate, extending the full width of the tank and shaped so that its upper surface is parallel with the surface of the roll. This plate also contains knives, set at an angle slightly oblique in relation to those in the roll. As the roll rotates, the pulp is circulated in the beater, passing repeatedly between these sets of knives. The beater is not an automatic machine; it is an instrument requiring intelligent and experienced control. Well-trained beatermen can tell by the mere feel of the stock how much further beating it will require. Upon the efficiency of the beater room depends much of the quality of the finished product.

Although paper is largely composed of cellulose, it is not entirely so made up. In the beater room are added clay to lend body and opacity to the sheet, sizing substances to reduce absorbency, alum to fix the "size", and a number of other materials depending upon the grade of paper being made. All these are added according to rigid specifications established by the laboratory or research department. The matter of the coloring of paper is a highly technical subject in itself. It is an extremely difficult task to maintain constant color.

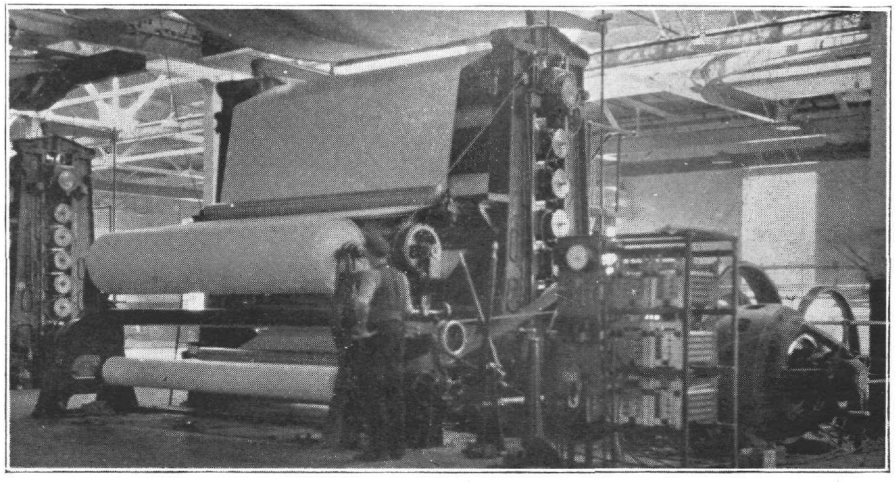
The beating time varies within wide limits of from thirty minutes to several hours. It will be seen that this depends much upon the furnish and especially on the condition of the pulp being used. For additional refining the stock may be forced through a Jordan engine, a conically-shaped machine, which contains knives that shear in much the same manner as a lawnmower. Finally, greatly diluted with water, it is pumped to a stock chest where it is continuously stirred or agitated until such time as it is needed.

The machine ordinarily used for making paper is the Fourdinier machine, a highly complex apparatus. Although the many manufacturers introduce their own refinements, the principle of all is the same. It is not purposed here to give a technical description. Rather it is to outline briefly its function.

The stock previously mentioned is sent through a fine screen whose purpose it is to remove every possible trace of dirt, slivers, etc. Being now of constant consistency, it is flowed onto a very finely meshed, horizontal wire screen, made in the form of an endless belt and traveling away from the point where the stock is admitted. The rolls on which this wire rests are shaken by eccentrics; this stirs the fibers, causing them to felt more readily. The water in the stock drains rapidly through the wire, drainage being assisted by suction boxes located under the



The end of the intricate paper-making process.



The finished paper is here shown being rolled and made ready for shipment.

wire at certain points. At the end of the wire farthest from the point where the stock was admitted is a pair of rolls between which the film of fibers from the wire passes. The newly-formed sheet contains much moisture; it is, accordingly, taken between other felt-covered rolls which press still more water out of it. Next it is passed through a long series of steam-heated cylinders, made of iron, always supported by a layer of felt which travels with the paper. These dryers drive out all the remaining water except a small percentage always present even in paper commonly considered quite dry. Finally the paper passes through a vertical series of heavy, polished steel calender rolls to give it a "finish" and onto reels where it is wound up. The paper on the reels has a rough, uneven edge and is not wound uniformly. Therefore at least one more operation is necessary before it is ready for shipment.

The work of the finishing room divides itself into two general classifications, making rolls of paper and making bundles of paper, which are themselves much further subdivided. Whether bundles or rolls are to be made depends entirely on the purpose for which the paper is to be used.

The first classification is perhaps the simpler. In many cases the paper has been given sufficient finish by the calender stack at the dry end of the paper machine. The jumbo roll formed on the reel is rewound on a rewinder, incorporating various cutting devices, the adjustment of which enables the operator to obtain whatever size rolls his orders may call for. This work is done very carefully so that the rolls will have no hard and soft spots and that their edges may be trimmed quite evenly. The rolls are then taken to the roll finishing department where they are so wrapped as to prevent damage during transportation.

In some instances, the paper may require an additional gloss or finish. This necessitates running the paper through a super calender which gives a higher finish than that imparted by the stack at the dry end of the machine. Such paper is rewound and prepared for shipment as described above.

There now remains the other major phase of finishing, bundle finishing. One need only call to mind the stationery with which he is familiar to realize that rolls of paper must necessarily have been cut up. There are many other uses for paper which necessitate the sheet form. The jumbo rolls from the paper machine are placed on machines known as cutters. Upon adjustment, these unwind and cut the paper into sheets of any desired size. Usually the sheets are sorted and counted by hand, defective sheets being rejected. They are trimmed to exact size on a trimmer press, and then finally, wrapped and sealed in heavy paper or packed in wooden boxes. The long process of papermaking is completed.